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Pallmann

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(54) **DEVICE FOR COMMINUTING FEEDSTOCK**

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(51) **Int. Cl.**

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B02C 13/282	(2006.01)
B02C 13/18	(2006.01)
B02C 13/14	(2006.01)

(52) **U.S. Cl.**

CPC ***B02C 13/282*** (2013.01); ***B02C 13/09*** (2013.01); ***B02C 13/18*** (2013.01); *B02C 2013/145* (2013.01)

(58) **Field of Classification Search**

CPC B02C 2/10; B02C 19/22; B02C 13/09; B02C 13/18; B02C 13/282; B02C 18/007; B02C 2/007; B02C 13/28

USPC 241/188.2, 261.1, 294, 295, 298, 260.1

See application file for complete search history.

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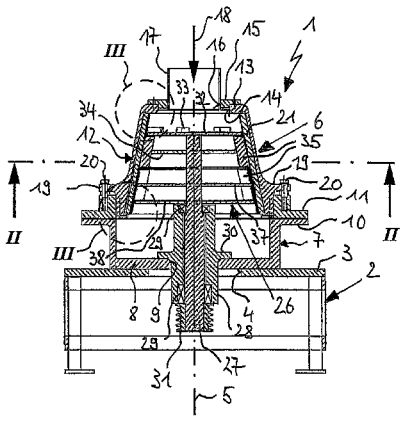
(57) **ABSTRACT**

A device for comminuting feedstock having a rotor, rotating within a housing around an axis, with rotor tools lying within the outer circumferential region on a circumferential ring and a stator, associated with the rotor, with stator tools arranged concentrically in the outer circumferential region and forming a comminuting surface, whereby the rotor tools and the stator tools lie opposite at a distance with the formation of a working gap and the stator tools are formed by segments, which to form the comminuting surface rest on the stator with their rear side and lie with their long sides against one another. The segments are attached to the stator in each case with their first short side and second short side by a positive fit, whereby the stator has a clamping element, which works together with the first short side and/or second short side to clamp the segments against the stator.

13 Claims, 5 Drawing Sheets



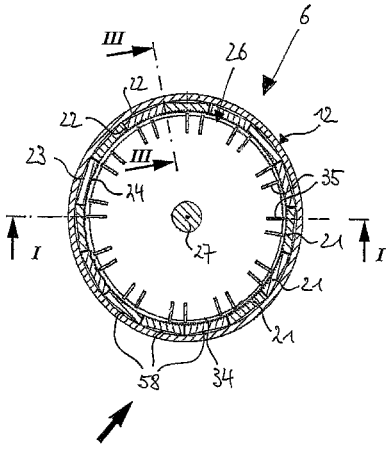


Fig 1

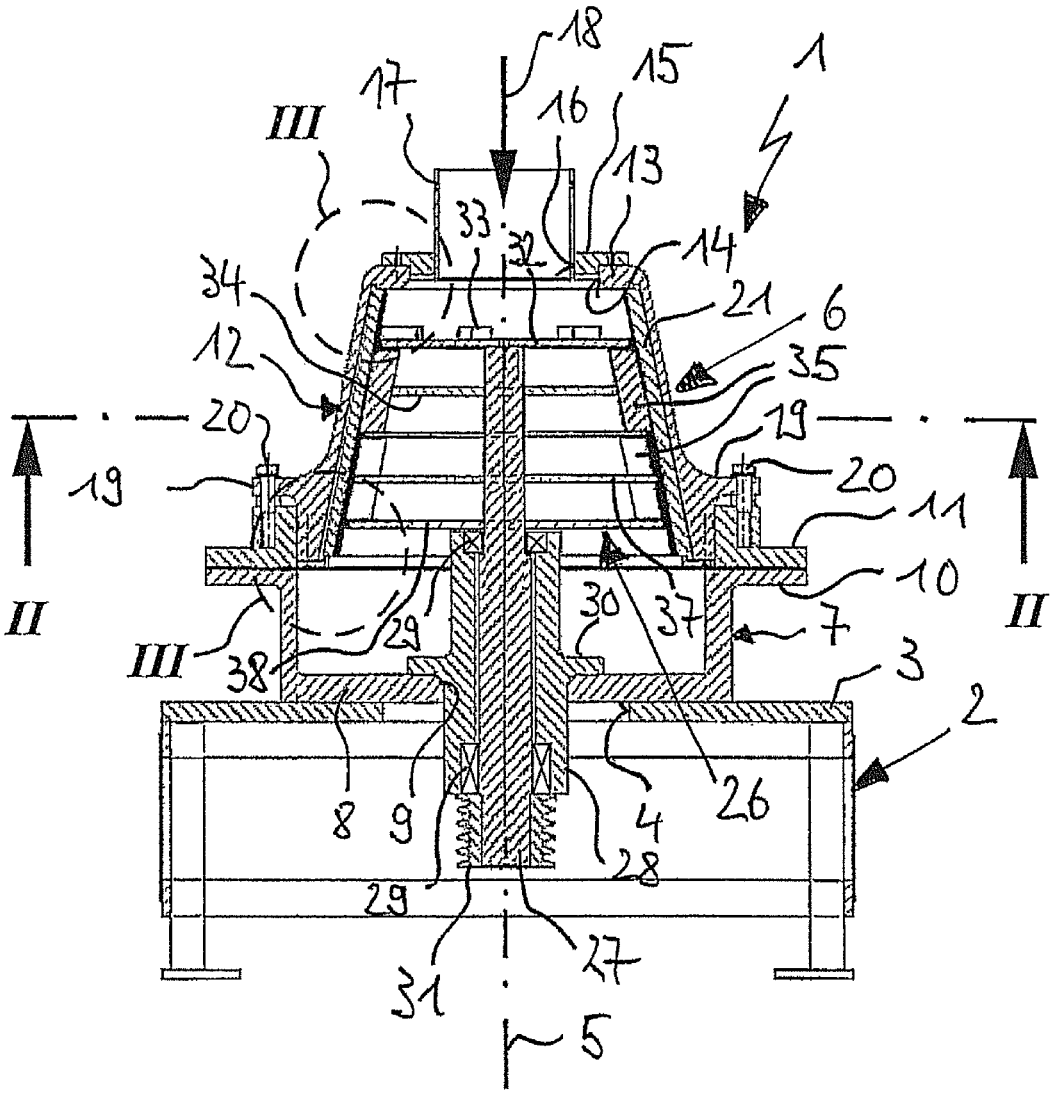

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Fig 2

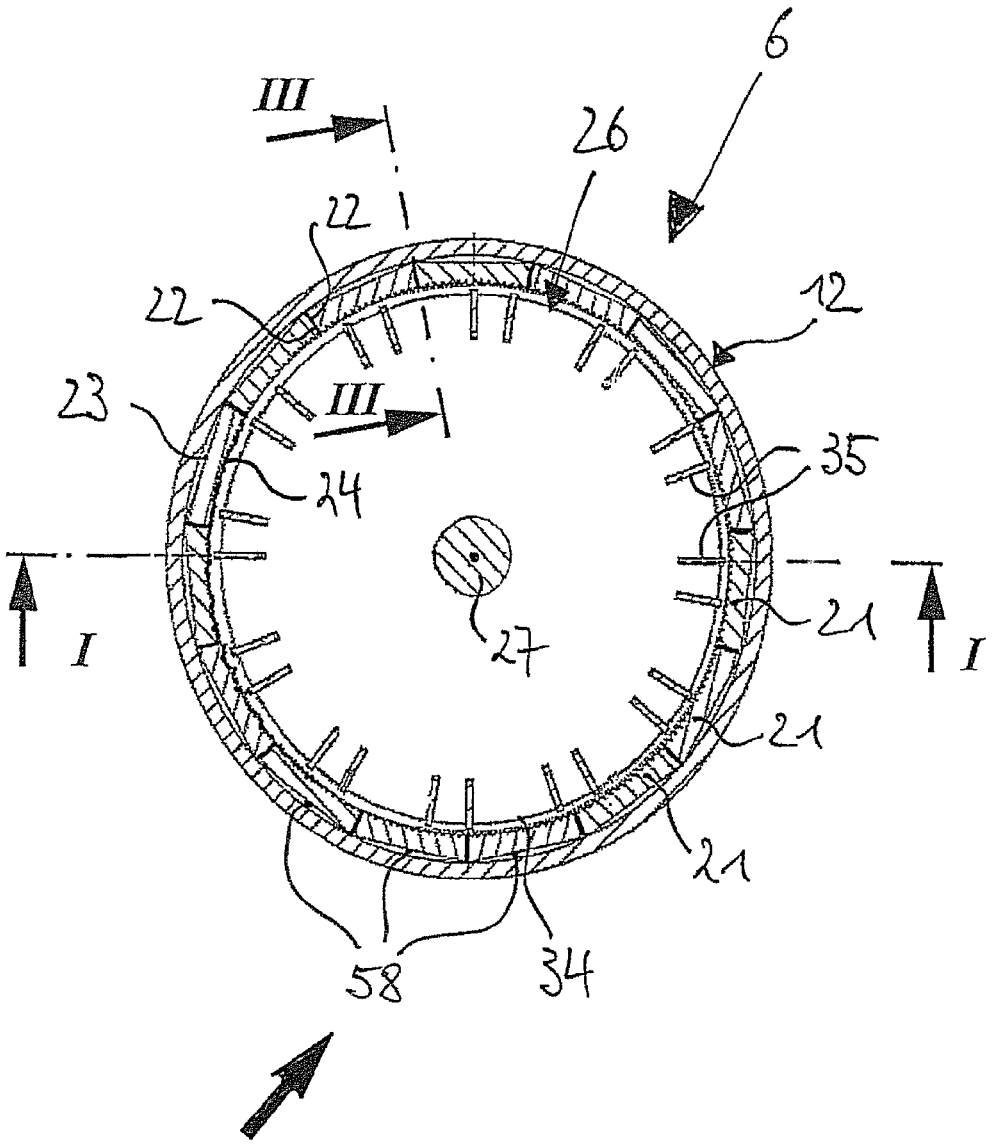


Fig 3

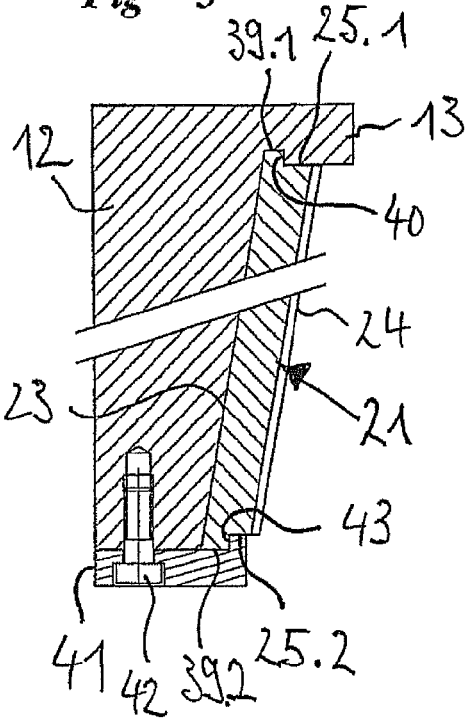


Fig 4

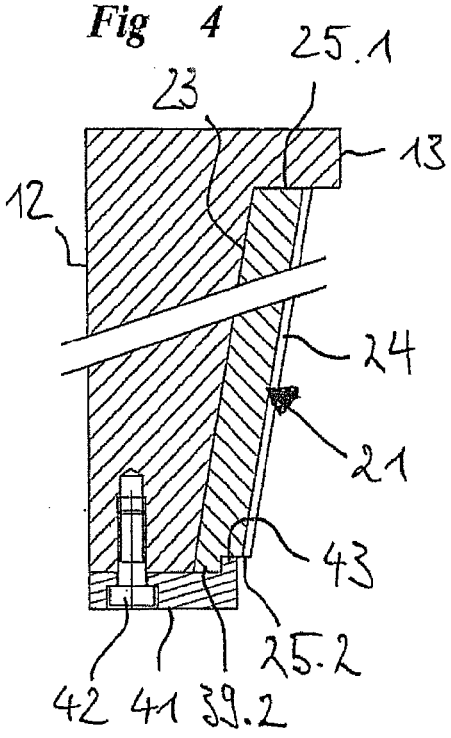


Fig 5

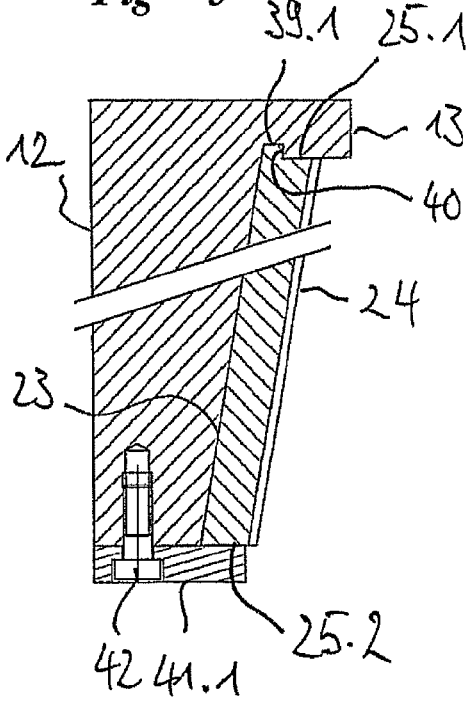


Fig 6

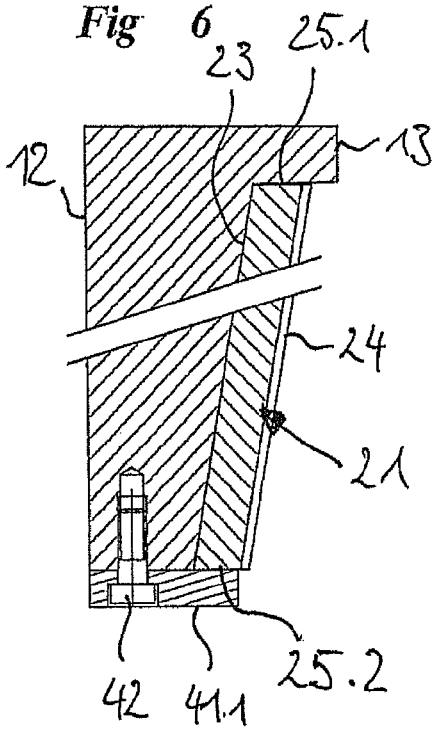


Fig 7

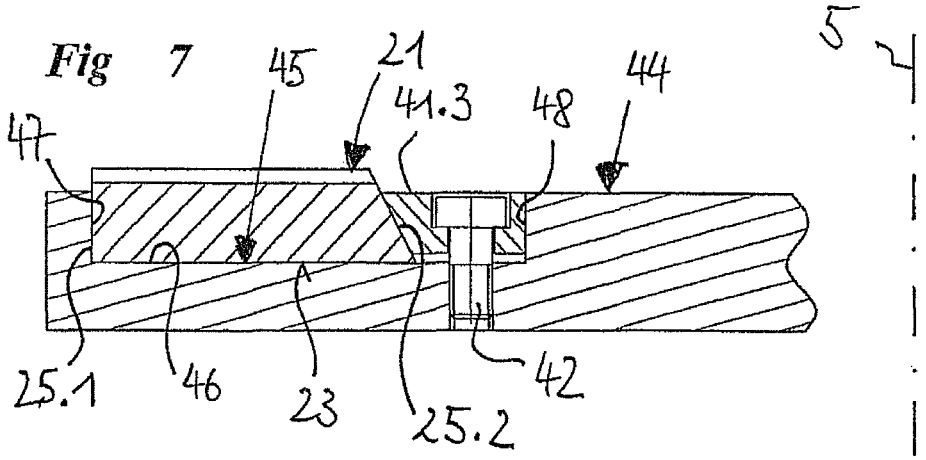


Fig 8

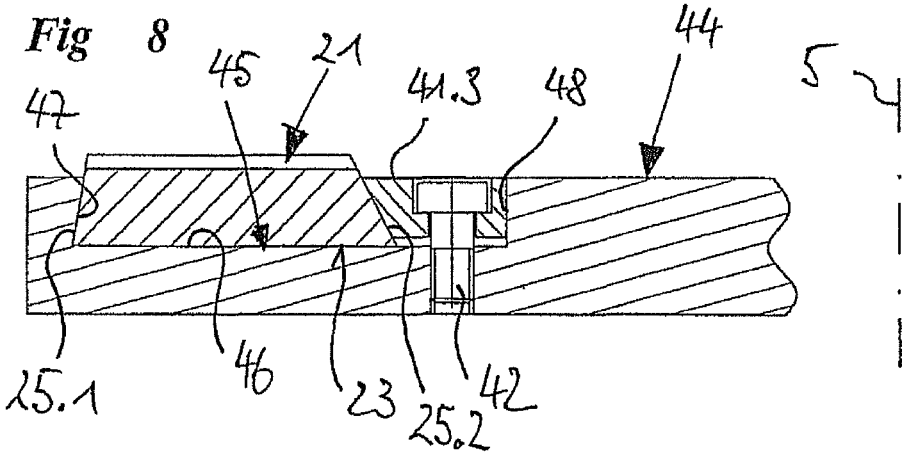


Fig 9

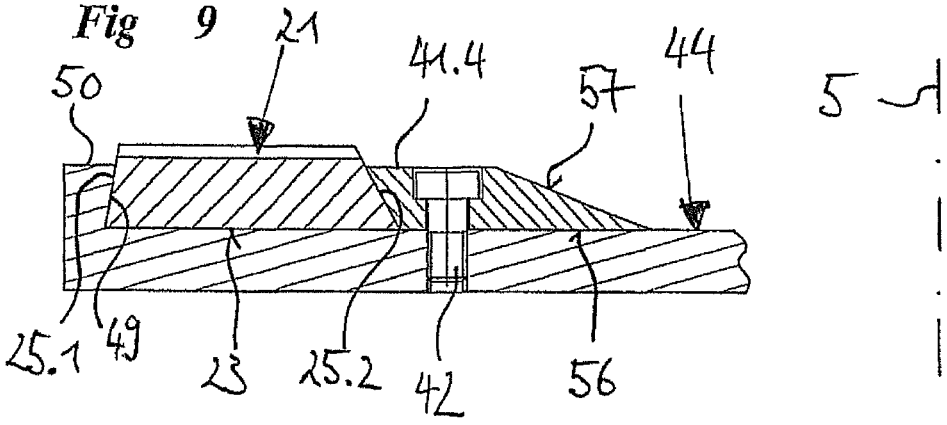


Fig 10

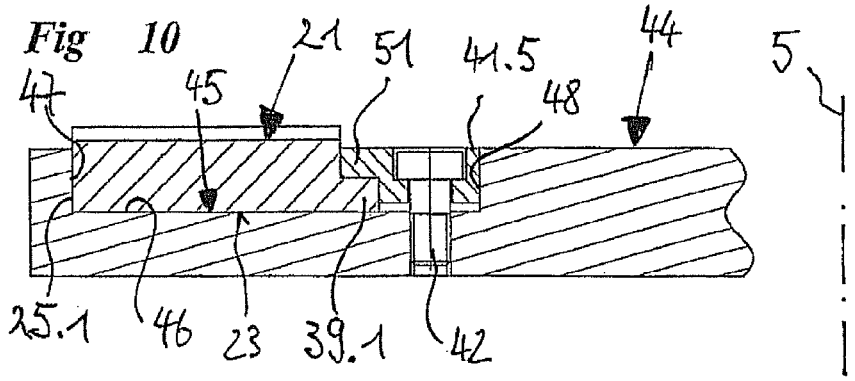


Fig 11

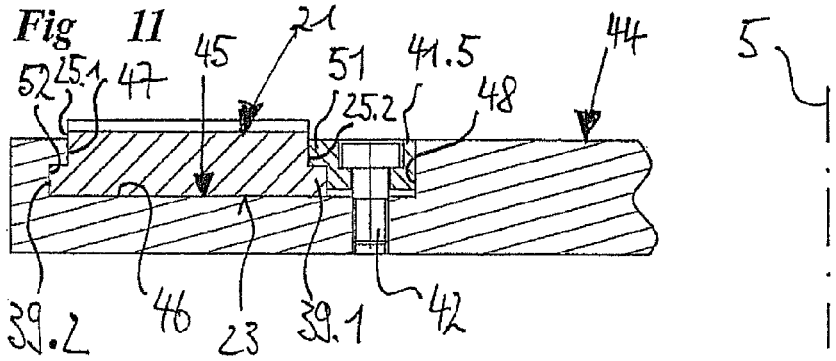


Fig 12

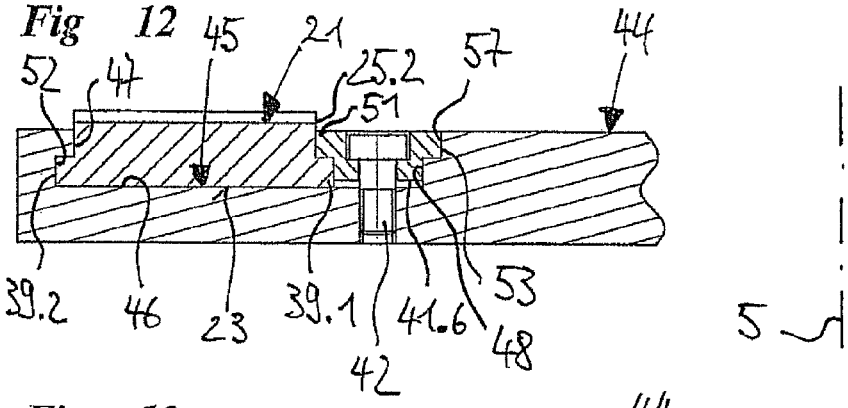
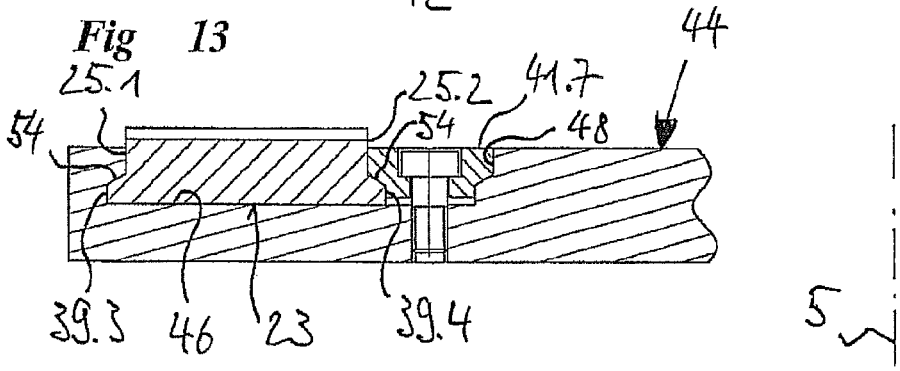


Fig 13



DEVICE FOR COMMINUTING FEEDSTOCK

This nonprovisional application claims priority under 35 U.S.C. §119(a) to German Patent Application No. DE 20 2010 006 173.3, which was filed in Germany on Apr. 27, 2010, and which is herein incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a device for comminuting feedstock.

2. Description of the Background Art

Devices of this type belong to the field of mechanical process engineering, particularly the conversion of a feed material into an end product of predefined shape and size by way of comminution. Such devices include, inter alia, disc mills, such as those disclosed, for example, by German Utility Pat. No. DE 202 16 056 U1, which corresponds to U.S. Pat. No. 7,134,463. Such disc mills have a rotor, which works together with a stator within a housing. The rotor includes a carrier disc, which is equipped along its outer circumferential area with grinding tools lying within the disc plane. The grinding tools lie opposite to stationary stator tools, arranged at the inner housing wall concentrically around the axis of rotation, at an axial distance with the maintenance of a grinding gap.

Both the rotor and stator tools can be formed by segments and are screwed onto the carrier disc or to the housing wall. This very time-intensive work increases not only the assembly costs during wear-related tool replacement, but also concurrently increases the length of downtimes of the disc mill, which conflicts with efficient utilization. For this reason, rotor and stator tools, which have a complete ring that can be replaced as a whole unit, are already in use in disc mills. This does in fact shorten the tool replacement times, but the profile of the grinding tools is limited in terms of manufacturing technology to a substantially radial fluting.

The conventional art also includes mills, such as those described, for example, in European Pat. Appl. No. EP 2 070 596 A1. The mill disclosed therein has a cone-shaped housing, whose inner circumference is provided with a grinding bed insert, shaped like a hollow truncated cone, to form a stator. Arranged coaxially within the grinding bed insert is a rotor, whose rotor tools are formed by radially oriented impact plates, which are suspended in a pendular manner and with maintenance of the grinding gap strike along the inner circumference of the stator tools. The grinding bed insert, shaped like a hollow truncated cone, forms the stator tools and is inserted as a whole unit into the housing, whereby a clamping ring at the larger-diameter front end of the housing assures the securing against axial positional changes of the grinding bed insert. As in the case of the previously mentioned one-piece tool rings in disc mills, based on the monolithic design of the grinding bed insert here as well only a substantially coaxial fluting on the inner circumference of the grinding bed insert is possible. Variations in the geometry of the fluting, to match the stator tool active surface for comminution to specific feedstock or to achieve a specific processing result, are not possible.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to develop further conventional devices in regard to shortest possible downtimes during tool replacement and greatest possible flexibility in matching the stator tools to the feedstock and to the end product requirements.

Due to the invention, it is possible to satisfy simultaneously the thus far mutually exclusive requirements in the prior art for the most rapidly possible replacement of comminuting tools, on the one hand, and a greatest possible freedom during the selection of the type of fluting of the comminuting tools, on the other, within a device.

By means of the segment-like design of the stator tools it is possible for two successive segments to have a different fluting, as a result of which both the intensity of the comminution and the residence time of the feedstock within the comminution area can be controlled. At the same time, for assembly, the segments are merely placed in the stator and then fixed in their position with a clamping element. Extremely short downtimes caused by tool replacement can be achieved in this way. The invention therefore makes possible a more economic operation of the device of the invention by means of a simplified tool replacement with simultaneous qualitative improvement of the processing result due to the possibility of being able to better match the stator tools to the specific general conditions.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitive of the present invention, and wherein:

FIG. **1** shows a vertical section through a device of the invention along the line I-I depicted in FIG. **2**;

FIG. **2** shows a horizontal section through the device shown in FIG. **1** along the line II-II there;

FIG. **3** shows a detail of the device shown in FIG. **1** in the areas designated by III;

FIGS. **4** to **6** show alternative embodiments to the solution shown in FIG. **3**; and

FIGS. **7** to **13** show corresponding detail solutions in conjunction with the devices of the invention in the form of disc mills.

DETAILED DESCRIPTION

FIGS. **1** and **2** depict a vertical and horizontal section through a device of the invention in the form of a mill **1**. A frame-like base **2** can be seen, which is made of steel profiles and with its top side forms a horizontal platform **3** with central opening **4**. Base **1** supports mill **1** of the invention, whose axis of rotation **5** is oriented perpendicular to platform **3** and extends through central opening **4**.

Mill **1** comprises a housing **6** with a bottom part **7**, which is formed by a cylindrical trough. Bottom **8** of the trough has a circular opening **9** concentric with the axis of rotation **5**. Bottom part **7** is open upwards, the edge being formed by a circumferential annular flange **10**. Annular flange **10** is used to support and attach a concentric bearing ring **11**, which is

formed angular in cross section and whose horizontal leg is connected to annular flange **10**.

Housing **6** continues upward in a bell-shaped upper part **12**, which is shaped like a hollow truncated cone and whose larger-diameter bottom side is open and associated with bottom part **7** and whose smaller-diameter top side has an opening **14**, which is limited by a circumferential collar **13** radially facing inward. A removable cover **15** is bolted together removably with collar **13** and has a concentric feed opening **16**, to which a feed connecting piece **17** is attached. Arrow **18** represents the feedstock which is fed axially into mill **1** through feed connecting piece **17**.

The larger-diameter bottom side of upper part **12** has a circumferential annular flange **19** at the outer circumference, said flange which is supported via adjusting screws **20** on the vertical leg of bearing ring **11**. In the housing section between annular flange **19** and the larger-diameter front end of upper part **12**, the outer housing covering is formed cylindrically, in order to be guided with an accurate fit and axially movable within bearing ring **11**. The distance between bottom part **7** and top part **12** can be adjusted by adjusting screws **20**.

Upper housing part **12** with its inner circumference forms the stator, along which fifteen segments **21** forming the comminuting surface are arranged. The long sides **22** of segments **21** are formed for this purpose so that they run in each case within the axial planes relative to the axis of rotation **5**. Segments **21** butt-jointed in the circumferential direction in this way form the stator tools of the rotor-stator system. To secure the relative position of segments **21** relative to one another, it is also possible to provide the mutually associated long sides **22** of two adjacent segments **21** with positive-fit elements, for example, in the form of a tongue and groove, which is not illustrated, however.

The cross section of segments **21** is evident primarily from FIG. **2**. Accordingly, segments **21** have a planar rear side **23** and lie only with their longitudinal edges formed by rear side **23** and long sides **22** in each case linearly against the conically extending inner jacket of upper part **12**, which results in a polygon-like course of the rear side of the comminuting surface. The linear mounting along the longitudinal edges, moreover, makes assembly easier compared with flat mounting, because manufacturing-related inaccuracies within the bearing surface would impede a snug seating of segments **21**. Because the inner side of upper housing part **12** has a constant curvature, hollow spaces **58** which have a cross section in the form of circular segments and can be used, for example, for conveying a cooling medium, form between upper housing part **12** and the rear sides **23** of segments **21**. The front side **24** of segments **21** has an arcuate curvature and is provided with fluting.

The size of the hollow spaces **58** resulting between segments **21** and the inner side of upper housing part **12** depends, inter alia, on the number of segments **21**. The invention prefers a number of segments between 12 and 20, preferably between 15 and 18. A segment **21** therefore extends over 1/12 to 1/20, preferably over 1/15 to 1/18 of the inner circumference of the stator.

The particular formation of the two short sides **25** of segments **21** will be described in greater detail in regard to FIGS. **3** to **6**.

A rotor **26** rotating around the axis of rotation **5** is evident within housing **6**. Rotor **26** comprises a shaft **27**, which is retained within a cylindrical shaft bearing **28** in bearing assembly **29** coaxially with the axis of rotation **5**. In this regard, shaft bearing **28** is inserted over part of its length into opening **9** in bottom **8** of bottom part **7**, whereby an annular flange **30** outwardly surrounding shaft bearing **28** is used for the positionally precise attachment of rotor **26** relative to housing **6**. A multiple-groove pulley **31**, which is coupled to a drive not shown in greater detail, is seated on the end of shaft **27** lying outside housing **6**.

An impact plate **32** is attached on the face side to the opposite end of drive shaft **27** concentric with the axis of rotation **5**. Hammering blocks **33**, arranged in the circumferential area, at their top side facing feed opening **16** form a first comminuting stage for the feedstock entering mill **1** via feed connecting piece **17**.

There is a first carrier disc **34** also seated concentrically on shaft **27** at an axial distance to impact plate **32**; rotor tools are arranged in pairs in the form of impact plates **35** at the circumference of the carrier disc. In this case, the effective edges of impact plates **35** run parallel to the surface lines, forming the front side **24** of segments **21**, with maintenance of a radial working gap. A first retarding disc **36** is arranged concentrically plane parallel and at an axial distance on drive shaft **27** in the direction of bottom part **7**. The first retarding disc **36** is used to control the residence time and the material stream through mill **1** of the invention.

Another comminuting stage is formed by a second carrier disc **37** attached concentrically to shaft **27** and is equipped like the first carrier disc **34** with impact plates **35** at its circumference. Finally a second retarding disc **38**, seated concentrically on shaft **27**, follows in the flow direction through mill **1**.

Details of the attachment of segments **21** to upper part **12** of housing **6** emerge from FIG. **3**. In this regard, FIG. **3** shows a section, as indicated with III-III in FIG. **2**, and thereby is within the butt joint of two adjacent segments **21**.

Each segment **21** for its attachment to upper part **12** along both short sides **25.1** and **25.2** in each case has an arcuate ledge section **39.1** and **39.2**. In the installed state, ledge sections **39.1** and **39.2** of all segments **21** form a circular ledge, which runs concentrically around the axis of rotation **5**.

For the positive-fit receiving of ledge section **39.1** at the first short side **25.1** an annular groove **40**, likewise concentrically surrounding the axis of rotation **5**, is arranged in upper housing part **12** on the inner side of collar **13**. This enables the insertion of segments **21** with their ledge sections **39.1** into annular groove **40** in upper part **12** employed for assembly. In so doing, segments **21** reach the inner side of upper part **12** only with the longitudinal edges formed by long sides **22** and rear side **23**.

To attach segments **21** in the area of the larger-diameter bottom side of upper part **12**, a likewise concentric clamping ring **41** is provided, which can be clamped by means of screws **42** against the front end of upper part **12**. Clamping ring **41** extends with its inner circumference radially inward via the opening to the bottom side of upper part **12** and has an annular shoulder **43** emerging axially from the ring plane, which during setting of clamping ring **41** on upper part **12** already equipped with segments **21** engages behind ledge section **39** at the second short side **25.2** of segments **21** and thereby assures their positionally precise position.

In comparison with the embodiment shown in FIG. **3**, the embodiment illustrated in FIG. **4** shows a simplified solution with respect to the manufacture of the device. In this case, the positive fit in the area of the first short side **25.1** is not produced by a tongue and groove construction. Instead, the first short side **25.1** and upper housing part **12** are formed in the common contact area and lie within a radial plane relative to the axis of rotation **5**. In the area of clamping ring **41**, the two embodiments according to FIGS. **3** and **4** are similar, so that the foregoing statements apply here as well.

In the embodiment according to FIG. **5**, the bracing of the first short side **25.1** in upper housing part **12** corresponds to that described in regard to FIG. **3**. In contrast, the second short side **25.2** has a planar area within a radial plane, said area on which a clamping ring **41.1** with a correspondingly planar form acts.

The embodiment according to FIG. **6** shows the greatest degree of simplification. Both the first top side **25.1** and second top side **25.2** of segments **21** are formed as planar here and are held in the axial direction by correspondingly planar bearing surfaces in upper housing part **12** or at clamping ring **41.1**. The embodiment according to FIG. **6** shows to a certain extent a combination of the embodiments shown in FIGS. **4** and **5**. A securing of the position of segments **21** in the radial direction results from the ring-shaped arrangement of segments **21** around the axis of rotation **5**, whereby segments **21** are mutually braced via their long sides **22** and radially inward movements due to arching are prevented.

FIGS. **7** to **13** relate to embodiments of different arrangements of segments **21** at stationary or also rotating bearing elements, whereby the planes of attachment are each within a radial plane relative to the axis of rotation **5**. Such solutions are suitable for implementing the invention in disc mills, for example, according to German Utility Pat. No. DE 202 16 056 U1 mentioned in the introduction to the description.

In FIG. **7** a bearing element is designated with reference character **44**, for example, a rigid or rotating bearing disc or a rigid housing wall. The comminuting tools, arranged in a circle around the axis of rotation **5**, in the form of segments **21** are visible on the side of carrier element **44**, said side facing the grinding gap. To attach segments **21**, a recess **45** with a rectangular cross section, surrounding the axis of rotation **5** concentrically, is arranged in the surface of carrier element **44**; the recess is formed by a bottom **46**, an outer wall **47**, and an inner wall **48**.

Recess **45** is used for receiving segments **21**, which with their rear side **23** rest with their entire surface against bottom **46** and with their first short side **25.1** with their entire surface against outer wall **47**. The radial size of recess **45** is selected such that an annular space, which is used to receive a clamping ring **41.3**, results between inner wall **48** and segments **21**. In this regard, clamping ring **41.3** rests with its inner circumference against inner wall **48**, whereas the outer circumference decreases in the direction toward the side facing bottom **46** to form a sloping circumferential surface. Clamping ring **41** acts via this sloping surface together with segments **21**, whose second short side **25.2** widens linearly with the formation of a correspondingly inclined surface toward the rear side **23**. In this way with the tightening of screws **42** a clamping force, acting radially outward against outer wall **47** and axially against bottom **46**, is transmitted to segments **21** via the clamping ring **41.3**.

FIG. **8** differs from this embodiment only in that outer wall **47** is undercut toward bottom **46**. The first short side **25**, formed complementary thereto, of segment **21** engages behind the undercut wall **47** and is secured in this way in addition against axial lifting.

The embodiment of the invention as shown in FIG. **9** differs from the two previously described embodiments in that carrier element **44** has no channel-like recess **45**, but a substantially planar surface, which has a circular wall **50**, projecting from the plane, only at the outer circumferential area; the radially inwardly facing side **49** of said wall is undercut so that these areas correspond to the corresponding outer circumferential area of the embodiment shown in FIG. **8**.

Clamping ring **41.4** has an outer circumference, corresponding to that described in FIG. **8**, and therefore works together with the sloping second short side **25.2** as described in FIG. **8**. In contrast, the inner circumference of clamping ring **41.4** is greatly widened in the direction toward carrier element **44** with the formation of an incline **57**, to achieve as large a support area **56** as possible of clamping ring **41** at the planar top side of carrier element **44**.

The embodiment according to FIG. **10** corresponds in many parts to that described for FIG. **7**. There are differences in the area of the second short side **25.2** of segments **21**, which widens in steps toward the rear side **23** of segments **21** with the formation of a rectangular ledge section **39.1**. Clamping ring **41** has an outer circumference, formed complementary thereto, with an annular flange **51**, which clamps ledge section **39.1** axially against bottom **46**.

The embodiment according to FIG. **11** is similar to that described for FIG. **10** with the difference that segments **21** widen in steps also in the area of the first short side **25.1** toward rear side **23** and thereby form a ledge section **39.2**, which engages with a positive fit in a corresponding groove **52** in outer wall **47**. Segments **21** therefore have an axially symmetric cross section.

The embodiment of the invention shown in FIG. **12** differs from this in a clamping ring **41.6** axially symmetric in cross section. Clamping ring **41.6** has, as described in FIG. **11**, a circumferential annular flange **51** at the outer circumference. In addition, there is a second annular flange **53**, which is arranged in an analogous manner at the inner circumference of clamping ring **41.6**. Inner wall **48** has a geometry complementary thereto with a ring-shaped recess **55**, so that upon tightening of screws **42** clamping ring **41.6** rests both on ledge section **39.1** of second short side **25.2** and on recess **55** in inner wall **48** and is therefore stressed symmetrically.

A variant of this is the subject of the embodiment disclosed in FIG. **13**. Here, short sides **25.1** and **25.2**, widening in the direction of rear side **23**, each have ledge sections **39.3** and **39.4**, with incline **54** sloping toward the outer circumference or the inner circumference in the direction of rear side **23**. Upon clamping of the complementary formed clamping ring **41.7**, in the contact area to segment **21**, a radially outwardly directed component is generated in addition to the clamping force directed against bottom **46**. An axially symmetric embodiment of clamping ring **41.7** in cross section and a complementary shape of wall **48** ensure a symmetric stress on clamping ring **41.7**.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are to be included within the scope of the following claims.

What is claimed is:

1. A device for comminuting feedstock, the device comprising:

a housing;

a rotor configured to rotate within the housing about an axis;

rotor tools arranged within an outer circumferential region on a circumferential ring; and

a stator associated with the rotor, the stator having stator tools arranged concentrically in the outer circumferential region and forming a comminuting surface,

wherein the rotor tools and the stator tools lie opposite to one another at a distance thereby forming a working gap,

wherein the stator tools are formed by segments, which to form the comminuting surface rest on the stator with their rear side and lie with their long sides against one another,

wherein the segments are attachable to the stator with their first short side and second short side by a positive fit,

wherein the stator has a clamping element, which contacts the first short side to clamp the segments against the stator,

wherein an extending direction of the first short side and the second short side is parallel to the first short side and the second short side,

wherein the extending direction is perpendicular to an axial direction of the axis,

wherein the stator includes a circumferential collar portion that protrudes from the stator,

wherein the second short side of the segments directly contact the circumferential collar portion,

wherein the clamping element is a clamping ring that is detachable from the stator and is concentric with the stator so as to clamp all of the segments,

wherein the clamping ring directly contacts both the stator and the first short side of all of the segments,

wherein the rotor and stator are formed cylindrical or conical, and

wherein the segments have a flat, planar rear side and along the longitudinal edges, formed by the rear side and long sides, rest against the stator.

2. The device according to claim **1**, wherein an edge between the first short side and the second short side at the rear side of the segment is wider than an edge between the first short side and the second short side at a front side of the segment.

3. The device according to claim **2**, wherein at least one of the first short side or the second short side of the segment has a stepped formation to form a ledge section.

4. The device according to claim **1**, wherein the first short side and the respective associated clamping element have complementary formed contact areas.

5. The device according to claim **1**, wherein the clamping element is formed symmetric in cross section.

6. The device according to claim **1**, wherein the first short side and the second short side of a segment are each formed of a flat, planar surface.

7. The device according to claim **1**, further comprising at least one screw, wherein the clamping element is attached to the stator with the at least one screw.

8. The device according to claim **1**, wherein the clamping element is provided with an annular shoulder that fits into a corresponding recess of the first short side of each segment.

9. The device according to claim **1**, wherein the second short side of each segment is formed with a protruding ledge that fits into a corresponding groove of the circumferential collar portion of the stator.

10. The device according to claim **1**, wherein the stator tools are clamped via the clamping element to the stator only in a direction towards the stator.

11. The device according to claim **1**, wherein the entire second short side of the segments directly contact the circumferential collar portion, the entire second short side of the segments being parallel to the first short side of the segments that directly contact the clamping ring.

12. A device for comminuting feedstock, the device comprising:

a housing;

a rotor configured to rotate within the housing about an axis; and

a stator associated with the rotor, the stator having segments arranged concentrically in an outer circumferential region thereof,

wherein each segment has a front surface that forms a comminuting surface, a rear surface that at least partially abuts the stator, an upper surface, a lower surface and two side surfaces, the segments being arranged concentrically in the outer circumferential region such that a respective side surface of one segment opposes a respective side surface of an adjacent segment,

wherein the plurality of segments are attachable to the stator via a clamping element, the clamping element contacting the lower surface of the segments so as to clamp the segments to the stator,

wherein an extending direction of the upper surface and the lower surface is parallel to the upper surface and the lower surface, and the extending direction of the upper surface and the lower surface is perpendicular to an axial direction of the axis,

wherein an extending direction of the two side surfaces is parallel to the two side surfaces, and the extending direction of the two sides surfaces is parallel to the axial direction of the axis,

wherein the stator includes a circumferential collar portion that protrudes from the stator,

wherein the upper surface of the segments directly contact the circumferential collar portion,

wherein the clamping element is a clamping ring that is detachable from the stator and is concentric with the stator so as to clamp all of the segments,

wherein the clamping ring directly contacts both the stator and the lower surface of all of the segments,

wherein the rotor and stator are formed cylindrical or conical, and

wherein the segments have a flat, planar rear side and along the longitudinal edges, formed by the rear side and long sides, rest against the stator.

13. The device according to claim **12**, wherein the entire upper surface of the segments directly contact the circumferential collar portion, the entire upper surface of the segments being parallel to the lower surface of the segments that directly contact the clamping ring.

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